

Brenham, Tex. and Southington, Conn. These solutions include acid/salt components in a weight percent range of approximately 15% to 45%, promoters of about 1% by weight, and oxidizers in a range of 0% to 15% by weight. The selected chemicals are mildly reactive to the metal, creating a soft coating (called “blackmode”) on interface surface 52, which is removed through vibratory agitation of journal bearing(s) 44 with the media. In some instances, it may be desirable to introduce a second chemical solution into the vibratory bowl to further burnish journal bearing(s) 44.

[0019] A vibratory bowl is a conventional vibratory finishing unit and can be operated at 800 to 1500 revolutions per minute, at an amplitude of 1 to 8 millimeters. During operation, the chemical solution can be added on a flow-through basis, such that fresh solution is continuously introduced and used solution is continuously drawn off and discarded. Solution may be introduced at a rate of between about 0.25-0.4 gallons per hour per cubic foot (0.027-0.043 liters per hour per cubic meter). Operation of the equipment will generate heat that typically increases the temperature of the vibratory system (media, solution and parts) to about 35° C. over time.

[0020] The media can be abrasive or non-abrasive. Suitable ceramic media are composed of silica and alumina, in combination with other metal oxides. In one embodiment, media having a hardness of approximately 57 on the Barcol scale, can be used with the super-finishing process. Specifically, media such as TROWALPLAST PP can be used. This media is sold by Walther Trowal, Ltd., with a United States subsidiary in Grand Rapids, Mich. The media is composed of 50% (by weight) alumina bonded with an unsaturated polyester resin. It has a density of about 1.8 g/cm<sup>3</sup> and a crystal size of less than 0.9 mm. In another embodiment, media are composed of a metal (such as AISI grade 302 stainless steel) that is inert to the chemical treatment conditions. Metal media are available from various suppliers (for example Abbott Ball of West Hartford, Conn.) in a variety of shapes and sizes. A variety of processes and techniques as well as products (i.e. media, chemicals, solutions, and vibratory bowls) can be used to super-finish interface surface 52 of journal bearing 44 are commercially available through suppliers including RIM Chemical, Inc of Brenham, Tex. and Southington, Conn. As a result of the super-finishing process, interface surface 52 achieves a surface roughness of less than 5 micro inches (127 micro mm) measured on an R<sub>a</sub> scale. The smoothness of interface surface 52 along with its tribological pairing with inner surface 60 allows epicyclic gear system 36 to achieve the benefits previously discussed.

[0021] FIG. 3 shows a schematic, view of the entire epicyclic gear system 36 taken along section 3-3 of FIG. 2. Because FIG. 3 shows the entire epicyclic gear system 36, a plurality of star gears 38 are illustrated. These star gears 38 are mounted on carrier 48 by a plurality of journal bearings 44. In addition to the components previously discussed, epicyclic gear system 36 includes baffles or spray bars 64. FIG. 3 also better illustrates soft metal liner 66 on inner portion of star gear 38.

[0022] As discussed previously with reference to FIG. 2, lubricant introduced into the journal bearing/star gear interface spreads axially and circumferentially to form a load supporting lubricant film between journal bearing 44 outer surface and star gear 38 inner surface. After forming a film between journal bearing 44 and star gear 38, lubricant is discharged from the axial extremities of the bearing interface. Substantially all of the discharged lubricant is directed into the sun/star mesh, partly because of the presence of the

nearby baffle 64. The directed lubricant cools and lubricates the sun and star gear teeth and then is expelled from the sun/star mesh. The adjacent baffle 64 then guides substantially all of the expelled lubricant radially outwardly into the star/ring mesh. The lubricant is then ejected from the star/ring mesh and centrifugally channeled away from epicyclic gear system 36.

[0023] FIG. 3 shows liner 66 which comprises the inner portion of each star gear 38. Liner 66 defines inner surface 60 of each star gear 38. As previously discussed, liner 66 is formed by a soft metal material and wears against interface surface 52 of journal bearing 44. Together the composition of interface surface 52 (harder metal) and inner surface 60 (more soft metal) comprise a tribological pair. During operation inner surface 60 is worn by interface surface 52 (harder metal) such that inner surface 60 conforms to interface surface 52 to control friction therebetween. The super-finishing of interface surface 52 allows the interface surface 52 to achieve a surface roughness of less than 5 micro inches (127 micro mm) measured on an R<sub>a</sub> scale, and due to tribological pairing of interface surface 52 with inner surface 60, surface roughness of inner surface 60 also becomes relatively smooth due to operational wear. Thus, a reduction of friction can be achieved allowing for increased moment capability of epicyclic gear system 36 (i.e. star gear 38 can operate under greater applied forces before inner surface 60 seizes with interface surface 52) and reduced bearing/lubricant temperatures in the boundary regime between inner surface 60 and interface surface 52. By reducing the temperature in the boundary regime condition, operational wear between star gear 38 and journal bearing can be reduced, thus increasing the operation life of the epicyclic gear system 36. By increasing the moment capability of epicyclic gear system 36, the size and weight of epicyclic gear system 36 can be reduced.

[0024] While the invention has been described with reference to an exemplary embodiment(s), it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment(s) disclosed, but that the invention will include all embodiments falling within the scope of the appended claims.

1. A epicyclic gear assembly, comprising:

an assembly having a ring gear, sun gear, and at least one star gear enmeshed between the ring gear and sun gear;  
a carrier disposed adjacent the rotatable sun gear and star gear; and

a journal bearing disposed in the at least one star gear and connected to the carrier, the journal bearing having an outer radial surface with an amorphous surface finish of less than about 5 micro inches (127 micro mm) measured on an R<sub>a</sub> scale;

wherein the outer radial surface interfaces with an inner surface of the star gear.

2. The assembly of claim 1, wherein one of the inner surface of the star gear and the outer radial surface of the journal bearing comprises a soft metal and the other comprises a hard metal.

3. The assembly of claim 2, wherein the soft metal comprises a copper/lead alloy.